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AUTHOR Sunal, Cynthia Szymanski; Warash, Bobbi Gibson
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ABSTRACT

Techniques for encouraging young children to discover the purpose and use of maps are discussed. Motor activity and topological studies form a base from which the teacher and children can build a mapping program of progressive sophistication. Concepts important to mapping include boundaries, regions, exteriors, interiors, holes, order, point of reference, direction, and area. Beginning mapping activities should stress concrete physical relationships which the young child is able to conceptualize. Teachers should initiate mapping experience with young children by providing motor experiences inside and outside the classroom. These experiences can be followed by a transition in mapping experiences which moves from work with photographs and three-dimensional miniatures and models, to two-dimensional paper, and finally to lines. Microcomputers can add experience for children in a variety of ways, ranging from simple games using the area of squares to the construction of complex microworlds. Maps and globes must be present in the classroom and need to be referred to frequently. (RM)

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Mapping With Young Children

Cynthia Szymanski Sunai
West Virginia University

and

Bobbi Gibson Warash
West Virginia University

Presented at the Annual Meeting
of the National Council for the
Social Studies

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Introduction

Mapping is an explanation, a description, a structuring of an interaction between objects physically existing in space. Mapping concepts are, therefore, essentially space concepts.

Children's development occurs in space and in time. Space is explored very early in development so that, by the third month, babies are coordinating eyes with hand and foot and investigating space through this coordinated movement (Piaget and Inhelder, 1956). When children begin walking they extend their investigations. They soon learn to distinguish the far away object from that which is nearby. They also define the external outlines of objects and differentiate small, large and medium-sized objects. Sensory-motor space is constructed by the age of two. This is an understanding of space in terms of the individual's senses and motor activities and therefore is experience-based (Piaget and Inhelder, 1956).

Early understandings of space provide the information from which the representational mapping of space can be developed in later years. This development begins around age two. Laurendeau and Pinard (1968) suggest that the very young child begins developing rough representations of the space which she/he has experienced. These representations probably are simple rough approximations because the child's thought is limited and somewhat inflexible. Also, young children construct their mental image of space piecemeal. This image is not really one image, rather it is a mosaic of images. Each part of the mosaic is fragmentary. Each is distinct from the others. Each is the result of those perceptions provided by experience which have most strongly affected the child (Sauvy and Sauvy, 1974).

This mosaic of images is what Piaget and Inhelder (1956) are referring to when they discuss topological space. Topological space, in regards to the young child, means that, for the young child, the only spatial relationships which are really meaningful are those of a particular kind. These include neighborhood or proximity, enclosure (in two dimensions), envelopment (in three dimensions), continuity, separation and order. For example, the young child will carefully place blocks next to each other, making sure that each touches its partner. Yet the child will aim the line of blocks in any direction and will often end up with a wandering line which goes to no place in particular. The attention to detail is there but the holistic view is not. The close details such as proximity and careful ordering demand the child's attention while the larger organized static relationships are not developed. An object is not seen as being composed of points which are at invariant distances from each other. Nor does the child understand placing an object precisely in a frame or reference (Sauvy and Sauvy, 1974).

From the age of four or five, projective space and Euclidean space begin to be sketched in against this background of topological space. The predominance of topological considerations continues until the child begins to achieve concrete operations at around age seven. For example, a child who can distinguish her right from her left hand usually cannot correctly distinguish the right and left hands of a child facing her. Laurendeau and Pinard (1968) suggest this occurs because the child's thought is still centered on the partial and successive aspects of a situation. The child is not yet integrating the parts of the whole situation nor is she able to use reversibility. Projective relations, involving straight lines and perspective, begin development before age seven but are not thoroughly accomplished before this age. Topological and projective space concepts appropriate for young children include: continuity and discontinuity, open and closed curves, boundaries

and regions, points of reference, direction, size, and area. These concepts are of increasing importance in the daily life of children and adults. Maps, graphs, and diagrams incorporate these concepts and provide a variety of information dependent upon them and conveyed via such diverse means of floor plans for homes or graphs showing a city's population growth.

Egocentrism

As children strive to structure and understand the relationships occurring in the space around them their efforts are confounded by their egocentrism. An egocentric individual perceives the world from his/her point of view and cannot usually take the perspective of others (Pulaski, 1971). This individual is not aware of his/her inability to see things from another point of view. She simply assumes that hers is the correct and only viewpoint. Young children are able, in specific situations, to understand another's point of view (Liben, 1978). This understanding is dependent on the cognitive maturation of the child but also on the familiarity of aspects of the situation. By age four, Borke (1975) found that children could choose how the Sesame Street character Grover would view a rural scene such as a lake with a sailboat, farm animals and a house, from different positions. While the young child's egocentrism does confound their efforts to understand space relationships, this egocentrism is lessening. Experience in trying to understand such relationships confronts the child with different viewpoints. Such confrontation causes confusion which in turn causes an effort to resolve the confusion. In making this effort the child moves toward understanding and in moving towards understanding the child loses some of the egocentrism which caused the initial confusion (Flavell, 1977). Experiences which cause some confusion because of a child's egocentrism can have positive results. The important

consideration is whether minimal confusion is present. Minimal confusion presents a challenge, a challenge which can be met, a problem which can be solved. A situation which is highly confusing cannot be mastered by the child, because it is too difficult to be sorted out. Instead the child is likely to give it up with no resultant lessening of egocentrism. Many common early childhood experiences have potential for lessening egocentric views. As a child plays with blocks he tends to wonder around his construction and view it from different angles. This confronts him with sometimes radically different views. Dealing with these views lessens egocentrism.

Young children are quite egocentric and, therefore, have difficulty perceiving the world as represented on a map. They can work in limited ways with maps of familiar local areas since this familiarity overcomes some effect of their egocentrism. Beginning mapping activities should stress concrete physical relationships which the young child is able to conceptualize.

Closed Curves

Ms. Homitz began a list of closed curves inside her classroom. She made up the list in order to help herself become more aware of closed curves so that she would be better able to help children have experience with them. Some she identified were:

- the edge of the reading table
- the edge of the snack table
- the molding framing the bookcase
- the rim of the water table
- picture frames
- the edge of a paint can
- the edge of the rug in the reading area

The list continued but eventually Ms. Homitz gave up adding to the list. It would be almost endless. Starting the list had, however, accomplished what she wished to accomplish -- she certainly was aware of closed curves in her classroom.

A closed curve defines two spatial regions, an interior and an exterior. These remain two definite regions as long as the closed curves is essentially intact. Neither region shares anything in common with the other. The closed curve creates a division between them just as a fence divides the park inside it from the streets outside it or the edge of a bathtub separates the water in it from the floor area around the bathtub. The concept of a boundary easily becomes part of an investigation of interiors and exteriors because the boundary is the closed curve dividing the two.

Boundaries and Regions and Exteriors and Interiors

These are concepts which are involved in the game "Crossing the Barriers". In this game, children play on teams, each of which wears its own color armbands and matching hats. Teams take turns moving about, for example moving from the snack area to the block area or from the swing set to the sand box. As the children take turns they encounter barriers which have a team color on them such as a piece of rope or a wood plank. When children meet and pass a barrier with their color on it, they take off their hats. When the children encounter a barrier with another team's color on it, they put their hats on. Children are always "Hats off" in a certain region and soon they discover this. The barriers can help them define the boundaries of that region and determine whether they are in the interior of it. This game can be transferred to paper with the barriers represented by different colored paper strips and with colored counters representing the children. Activities such as "Crossing the Barriers" help children to develop a basis for understanding the boundaries and regions depicted on maps and globes.

Lots of opportunities occur daily for discussion of boundaries and regions and exteriors and interiors. Very young children often argue about their space, a place they have defined as their territory. For example, Laura and Lana argue over a very comfortable armchair. It's just the right spot to really relax with a book or a quiet toy. When one of them is sitting in this chair the other may push her out. Getting the "opponent" off onto the floor or up onto an arm of the chair has become the mark of gaining possession of it, often causing the "loser" to run off in tears to an adult. Laura and Lana have staked out a region with mutually-recognized boundaries. The adults around them also understand both the region and boundaries which have been established. Both children and adults know when a child is in the region's interior.

Tony, the teacher's aide, drew a picture of the armchair one day. Lana and Laura enjoyed talking about the drawing of their chair. Then they began to discuss their quarrels. Tony added a line around the chair's seat defining the region which indicated possession. Both children understood what the line indicated. Then, Tony drew pictures of other favorite spots in the classroom and drew a line designating the boundaries of the favored region. Other children were attracted to his drawings. Most of the children quickly understood what he was doing. Later, Tony worked with those children who didn't understand. With these children Tony used a string to mark out the boundaries which defined favorite classroom areas. All the children became interested in this activity. Tony gave them all long pieces of string. The next few days were spent in marking out boundaries. One child marked off the entire block area. Most children marked off an area for their cot at naptime. Gradually, some children included others in their region. There was a lot of opportunity to discuss sharing, arguing and other social and emotional aspects of the interaction which involved delimiting boundaries.

The sand table and clay modeling table are two other areas which offer opportunities to work with regions and boundaries and exteriors and interiors. The paths marked out in a sand table are often continuous and only sometimes, discontinuous lines. These lines can delimit regions.

A version of "Crossing the Barriers" can be played where all the sand toys of one color or shape are used in one region and not in another. Both the sand table and modeling clay and dough can be used by children to mark out their region. Then the children can be assisted in telling a language experience story about their region. Finally, an adult can make simple drawings of the region the child made in the sand or clay. Areas within the region can be labeled according to the child's directions.

A political map might be introduced to the children at this point. A good choice would be one of the United States which has states clearly marked out and in which a state is shown in a color which is different from its adjoining states. Children can then easily distinguish the state's boundaries and the region and its boundaries. Further study should occur only regarding questions brought up by the child because most children will not be ready for more advanced study.

Interiors and Exteriors

The concept of interiors and exteriors is closely linked to that of boundaries and regions. It does, however, deserve study of its own. Children enjoy climbing into a box, curling up in it, bouncing around in it and then climbing out again. Once outside they climb in it, ride along the top, roll over it, etc. All this activity contributes to their exploration of the box's interior and exterior. They begin to understand that interiors and exteriors are separate but necessarily interrelated. Some authors of children's books such as Mitsuma Anno have explored

the interior-exterior relationship and used it to create rather complex drawings about what seem to be simple topics in, for example, Anno's Alphabet. This ingenious, simple-appearing book presents letters whose sides fit in unique ways where the outside of a letter suddenly becomes its inside. Interiors and exteriors are, on one level, simple concepts and, on another level, complex concepts. Young children usually enjoy exploring these concepts and must be encouraged to do so, for there is much to learn in order to really understand these concepts.

Favorites of young children which encourage exploration of interiors and exteriors include:

boxes

tables with sheets spread over them to construct sides and,
tire tunnels.

Children should start with exploring using their whole body as they do with a large box. Then they've had lots of experience with such whole-body exploration, they can be offered an opportunity to work with interiors and exteriors in a more abstract way (Figure 2). First, they can work with dolls which are placed inside and outside something, such as a shoebox. They can paint the interior of a shoebox in one color and choose another for the exterior. Then, photographs of the children inside a box and laying on top of it can be examined. Photographs introduce two-dimensional interior and exterior views and move children into much more abstract activity. Finally children might be shown drawings of boxes and other objects and asked to place a cut-out figure inside the box or outside it. The use of drawings results in a very abstract activity so care must be taken to ensure that young children are ready for such a level of abstraction before they are introduced to it.

Dolls-----> Photographs-----> Drawings

Figure 2: Increasing the Level of Abstraction in Working with Interiors and
Exteriors

Mapped objects have both interiors and exterior. These maps range in difficulty but become very complex when cross-sectional views are presented, for example, a drawing of the layers of the earth's crust, which is a view of an interior. These types of maps are highly abstract and require the individual to work with a concept which cannot be seen in reality but which is deduced from physical evidence. Such a map involves more than a concept on interiors but it does require the concept as a fundamental contributor to the knowledge required for understanding. When young children are able to have a wide range of experience with the concepts of interiors and exteriors, they are able to construct personal versions of these concepts which are complex enough to allow additional construction as a result of further experience. This additional construction can develop concepts which are useful in understanding an abstract cross-sectional map. However, the use of a cross-sectional map is not appropriate with young children. Emphasis, instead, should be on those experiences which lay a foundation for the later understanding and use of cross-sectional maps.

Holes

After working with boundaries and the regions created by them, the concept of the hole can be investigated. Holes break up the continuity of a region. They represent a closed curve which introduces a new region, that which is inside the curve. The water in a pond constitutes a very different region from the fields surrounding it. When a region, for example that represented by a piece of drawing paper, has a hole punched in it, some of the area is lost to the region.

The hole is a new region. Besides a loss in area, the new region can also be thought of as no longer connected to the old region. The area inside each is not connected with the other. The boundary between them is the edge of the hole. Maps account for, and depict, the breaks in the connectivity of a region. A lake is carefully delineated so that it may be understood as representing a separate region even though it might be surrounded by another region. Young children cannot be expected to understand connectivity of regions and the existence of regions within regions.

They can, however, observe holes and investigate the characteristics of regions within regions. A hole in a sock through which a part of their heel can be seen is usually quite interesting to children, as are holes wherever they occur. Water in a puddle can be splashed and examined as can be the asphalt which surrounds it. Knotholes in wood and air spaces in bread are inviting to exploring fingers. Holes can be found almost anywhere. Their exploration builds up a pattern of regularities which must be understood in order to accomplish some portions of mapping.

Order

This is another concept important to mapping. Order requires that objects be represented in the arrangement in which they occur. If a bush, tree and sandbox are to be mapped, the viewpoint is determined then the appropriate order is faithfully reproduced. The viewpoint must be decided first. In Figure 3, the viewpoint is that of an observer standing with the bush closest in front of him. Another viewpoint could have been with the sandbox closest to the viewer and the bush farthest away. All mapping involves determining a viewpoint and then striving to faithfully represent the resultant order. This is why maps often contain an arrow pointing to an "N" (North). The reader can use this symbol to determine



Figure 3: A Person's Viewpoint of the Order of a Bush, Tree, and Sandbox
Depends on Where the Viewer is Located.

the map's viewpoint. Order is dependent on viewpoint but is important in itself. It is particularly important when a complex set of objects is being mapped. Order is investigated by young children when they physically explore their environment. They quickly spot a change in the order of a familiar environment as, for example, when a chair has been moved to a different spot. In addition to physical exploration of their environment, children can use maps such as that in Figure 3. These can be made in multiple copies in which the order is always the same but the distance between the objects varies. Day after day a new map can be presented to the children where the map is essentially the same as the previous day's map but the space between the objects has been increased. This would draw the children's attention to the space as being the only difference between the maps. It will be noticeable if these successive maps are displayed alongside each other. Order, then, becomes the important characteristics of such maps.

Points of Reference

Related to the concept of order is the concept of a point of reference. It begins with the child. The child him/herself is the first and most meaningful point of reference for perceiving space. This is apparent in the young child's egocentrism which makes it difficult for the child to take a viewpoint which is not his/her own (Ginsburg and Oppen, 1979). With young children the goal in studying points of reference is to encourage the child to experience many points

of reference with the child at the center. Several points of reference should also be experienced using the same set of variables. For example, a region in Johnnie's nursery school playground contained a tree, a fallen log, and a small pond (see Figure 4). The teacher encouraged Johnnie to sit in the tree with her and to tell her how he felt and what he saw. Later, she asked him to sit at the foot of the tree with her and tell her what he saw and felt. Over several days, Johnnie and his teacher looked at and talked about the same general view from different locations in the pond, on the fallen log, at the pond's edge. Johnnie noted different items from each location. His teacher asked questions which drew his attention to additional items, for example, she asked if he could see the hillside beyond the school when he stood in the pond. He could not see it but said that if she would help him climb the tree he would be able to see it.

All maps are drawn from a specific point of reference determined before the mapping is actually done. With young children, lots of points of reference should be experienced, and discussed. If the child appears ready, a transition can be made using photographs such as one of Johnnie in the tree or in the pond. These can be discussed. More abstract activity which could follow involves a drawing such as Figure 4 on which the child places a drawing of him/herself. This might be followed by a language experience story describing what the child



Figure 4: Points of reference can be studied in relation to locations using the same set of variables, for example, a tree, a fallen log, and a pond. A = in the tree, B = at the foot of the tree, C = in the pond, D = on the log, E = at the pond's edge.

saw from different locations. Johnnie's teacher has also photographed the different views from a child-sized height. Johnnie has identified each of these. He's also looked at them while on a return visit to the location and noted that he can see this here but not over there. Points of reference should be explored by young children through actually experiencing them. Extension of this experience with two-dimensional activities is possible for many children but should not be used as a substitute for experience.

Direction

This is a concept which is difficult for young children. Applying labels such as "north" or "left" to directions is impossible for most young children. Experience with moving different directions and in changing directions is most appropriate. Ann likes to drop stones into puddles on the sidewalk and to watch the outward movement of the ripples they cause. She also notices skid

marks left by cars on streets and by bicycle tires on sidewalks. She enjoys standing at the beginning of a sidewalk tire mark and acting out the skid. She usually moves in the direction in which the traffic flowing next to her is moving. Her parents will attach labels to her movement such as "going forward" or "going uptown." They also talk with her about going up the "up" escalator and down the "down" escalator.

Ann's parents make use of opportunities to note direction. They watch the wind blow leaves and litter along the sidewalk. They also watch boats move along the river and cars on the freeway. Ann has tried to fly a kite in the park and has watched her lost balloon float away. All these experiences are experiences with direction. All have been part of the many walks Ann takes with her parents, walks that provide Ann with lots of changes in direction but which finally take her back home. She's quite familiar with her neighborhood and will often guide her parents home-- will give the "directions."

Area

This is an abstract concept which is not fully grasped by the individual until middle childhood, age 9 approximately (Ginsburg and Oppen, 1979). For the young child, area might best be experienced through making comparisons. One puddle is larger than another, so are two tree trunks. One book takes up more space than does another. This cookie is bigger than that one. Frequent comparisons can also draw around two objects such as two plates, help an adult cut them out, then lay one on top of the other to compare their size. Of course this is best done first by using the plates, later by using the drawings. A chart can then be constructed placing the largest plate first and the smaller one next. Comparisons of area may be extended to three or more if the child is ready to work with them.

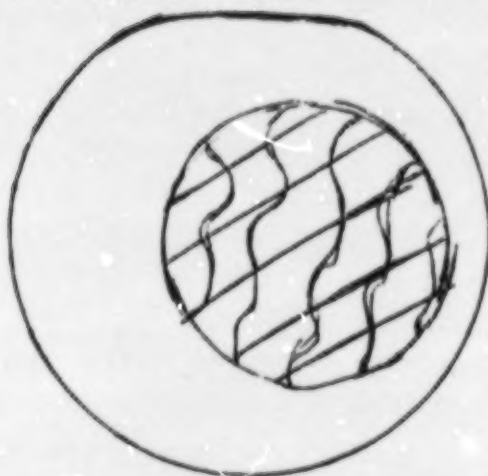


Figure 3: Comparing the Areas of Ordinary Items

Concrete to Abstract

Young children need to physically experience mapping concepts. Gradually, concrete experiences can be translated into more abstract form. For example, the shape of the playground pond can be drawn on the classroom floor, the fallen log can be represented by a masking tape rectangle, and the tree (see Figure 4) by a free form. Children can sit in the "tree", walk around the "pond" and lay next to the "log." These activities will allow children to perceive, imagine, and structure their body movements as they learn to recognize representational figures (Gerhardt, 1973).

Mapping activities should derive from body movement experiences in and around the objects and areas being mapped. Children's mapping experiences begin with themselves, then move out to their classroom and playground, and finally involve the environment beyond the school. While they are having basic experiences, children should be presented with maps of the places in which they are working. Exposure to maps will offer an opportunity to explore representational figures to those children who are ready for them.

Transition to Maps

A transition should be made to the use of maps in four steps (Gerhardt, 1973). First, a map of an area can be constructed using three-dimensional models which closely represent the real thing. There are many such models available. Commercial toys are available which are recognizable models of children, dogs, schools, barns, fences, etc. These can be used to recreate the child's classroom, playground, or bedroom. They can also represent a smaller region such as the block area or the kitchen table at breakfast time. Commonly available building toys such as Lincoln Logs and Lego's are useful in these activities.

Young children find the transition to three-dimensional models an easy one to accomplish. They more readily grasp the idea of reduced scale when three-dimensional models are used. A map of the children's play area, with miniature models of, say, a tree, a pond, and a fallen log (Figure 4) could be used. Children could then replace the miniatures with such nonthematic concrete materials as blocks and cardboard boxes as they move a step closer toward two-dimensional representation of objects.

Step two in the transition to maps is the use of three-dimensional models which are not thematic. Thus, an oatmeal box represents a tunnel, a silo, a tower of Detroit's Renaissance Center, or the tree on the school playground. A tuna-fish can might represent the above-ground pool in the backyard next door. A series of schoolboxes lined up next to each other make an excellent model of Baltimore's rowhouses. These models are more abstract than are the lifelike models used in step one, but they are close enough to the real object that children usually quickly understand them as representing the object.

The next step is the transition to two-dimensional representation. This is more difficult for children because it requires abstraction--the ability to form a three-dimensional mental image when only two dimensions are represented. Paper shapes replace the oatmeal boxes, tuna fish cans, and shoeboxes. Now the "tree" is a cylindrical paper cutout, topped with a green sphere, the fallen log and the pond (see Figure 4) are also flat pieces of paper.

The final step in the transition to two-dimensional is the use of line drawings instead of the paper shapes. The shapes can be traced in order to allow the child opportunities for matching the shape to the line drawings. Finally, miniaturization of the line drawings can occur as the children are ready for it.

The entire process of mapping can be summarized as (see Figure 6):

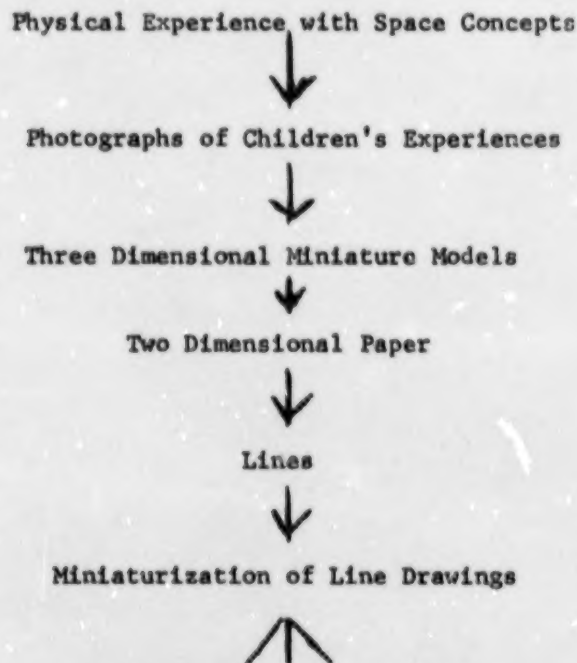


Figure 6: The Mapping Sequence

beginning with the child's physical experience of space concepts. This physical experience should occupy the largest portion of the child's time devoted to mapping. Second, photographs should be taken of children involved in physical space experiences. These can be discussed with the children and will serve as a springboard for other experiences. Third, three-dimensional thematic models are used to create realistic representations of a situation earlier experienced by the children and photographed by an adult. Fourth, three-dimensional non-thematic models are used to create a less realistic representation of a situation experienced by the children. Fifth, two-dimensional paper cutouts are used and seventh, the line tracings are miniaturized. As the mapping process moves beyond step one it becomes gradually more abstract. It should be expected that the number of children ready for each new step will decrease as the abstractness increases. Therefore, program emphasis for young children should be on step one.

Young children draw diagrams not pictures. They draw what they view as essential and leave out the details. Diagrams are drawings of only the essentials in a situation. For example, to get to Johnnie's house from a nearby highway you get off the highway at Exit 7, turn right onto Route 8, continue along Route 8 for $2\frac{1}{2}$ miles passing a gas station, then a church, then a grocery store, all on your right. Just past the grocery store, High Road comes into Route 8. You make a right onto High Road and follow it for $\frac{3}{4}$ mile passing three streets. At the fourth street, Calhoun, you turn right and it's the second house on your left. These directions are reproduced in the diagram in Figure 7. The diagram in Figure 7 does not specify directions except in terms of right and left. It gives no indication of the dimensions of the area described. It does, however, pay careful attention to the order in which places are found. It has some, but not all, characteristics of complete maps. Young children's drawings, and their explanations of their drawings, are similar to the directions and diagrams

of the route to Johnnie's house described above. For example, the young child draw stick figures. These represent the essential outline of the human body with the parts (head, arms, legs, trunk) shown in the proper order. Young children are drawers of diagrams. They also make maps that are diagrams. Some features, such as order, can be incorporated into their maps at an early stage. Other features, such as dimensions, will develop later. Adults who map with children should keep in mind the child's drawing through diagrams. Early maps should present only essential features in their correct order from a specified viewpoint.

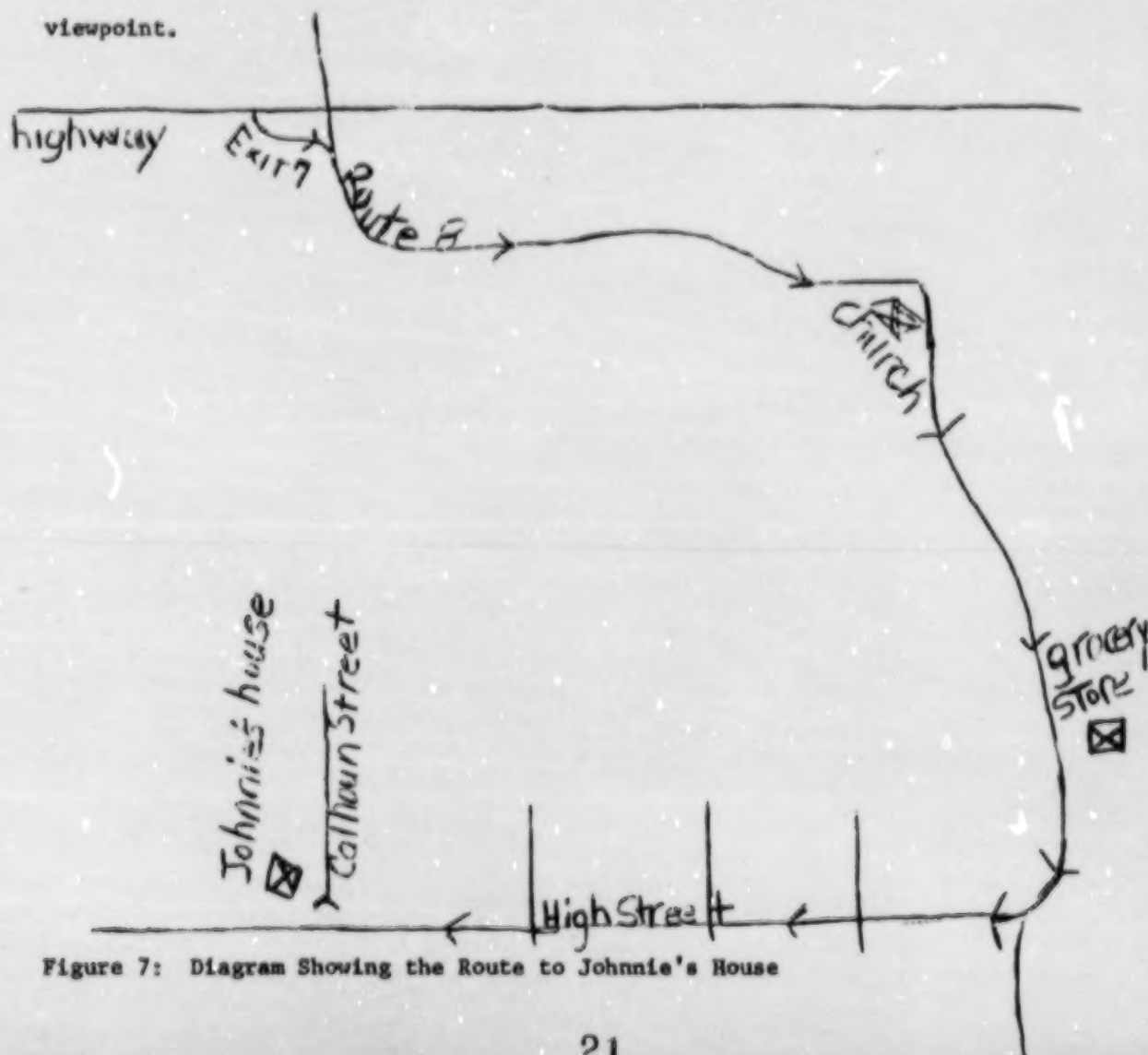


Figure 7: Diagram Showing the Route to Johnnie's House

When children are able to move through all seven steps of the mapping sequence, they are also ready to use commercial and homemade maps and globes with raised contours. They can "feel" the recessed and raised areas to determine similarities and differences among geographic regions. When commercial maps are used, maps of the same scale should be used as much as possible. Maps which contain two different scales such as a state map with an insert containing an enlarged city map, should not be used, since differences may confuse children (Towler and Nelson, 1969).

Mapping with the Microcomputer

Adults with easy access to a microcomputer, for example an Apple or an Atari, should consider its potential for use in mapping with young children. Computer graphics are particularly useful in mapping. Simple programs can be devised which supplement physical experiences. For example, area can be studied via a program which presents children with two blocks of different sizes and asks which is larger. This type of a program is possible on all microcomputers and can be written in BASIC (Beginners All Purpose Symbolic Instruction Code), a language which is available on microcomputers.

BASIC was designed at Dartmouth College in New Hampshire in 1964. Since then it has come to be the most widely used computer language by beginners and hobbyists. Its popular use is mostly due to its "on-line" use, where the microcomputer user types in something and gets an immediate response from the microcomputer. Many computer languages are so complex that an individual cannot easily sit down and type in commands, but must carefully plan the instructions ahead of use. Some other languages which are more complex but which have relatively straightforward on-line use are LOGO, FORTRAN, COBOL, RPG, and PL-1. Of these, LOGO has been specifically designed to be used in education.

Computer languages are usually limited in vocabulary and exacting in syntax.

A small change in a program of statements such as misspelling "PRINT" as "PIRNT" or using an instruction to the microcomputer such as "WRITE" instead of "PRINT" will often stop the running of the program of statements given the computer. Also, changing the order of the statements or changing, eliminating, or adding punctuation will either stop a program or cause it to do something not intended by the user. All computer languages have rules which must be strictly followed. The microcomputer can only do what it is directly asked to do. It cannot follow shortcuts or guess at what was intended by the user. This need to follow rules carefully is frustrating at first to the computer user. However, the user should remember that while the computer is a machine that can think it can only do so when told what processes to follow. At a much simpler level, the automobile will only go in reverse when put in reverse. The driver who puts an automobile in forward when he wants to go in reverse will find the automobile doing what it has been enabled to do, go forward, not what the driver wanted to do, go in reverse. Correct instructions really are important.

BASIC is easy to learn because it has only about fifty key words, such as "PRINT". It is preprogrammed into microcomputers, so it's there for the using. BASIC's very simplicity creates some problems in that to instruct the microcomputer using such a limited vocabulary sometimes means that a complicated series of instructions is needed. For example, imagine that you had a vocabulary of fifty words and wanted to give someone instructions on how to address an envelope. Your instructions might end up being very complicated in order to get around those words you do not have in your vocabulary. Despite this shortcoming, BASIC is heavily used in elementary and secondary schools and is

found in use in preschool programs because it is available on microcomputers. Its use in preschool programs is limited because children must learn this structured vocabulary and implement it carefully. Adults in preschool programs are more likely to be the actual users of BASIC as they set up activities children can do on the microcomputer.

Another language which is being used with young children is one which was especially designed for use with children, LOGO (Watt, 1982). It was developed at the Massachusetts Institute of Technology and is used by children to write programs that draw colorful geometric figures on the television screen. LOGO has a large vocabulary, little punctuation and the capacity to learn words the user wishes to teach it. It is a flexible language and one that is easy to learn to use partly because of its capacity to learn words the user teaches it thereby becoming the user's own language. It is now available for use on most of the popular, lower-priced microcomputers.

Developed along with the LOGO language was a small robot, called a turtle, which children can control and instruct. The robot has a pen with which it can be instructed to draw. It also has a horn which it can be instructed to toot. It can go forward and backward and can turn at any angle. The robot is controlled by the child and can become an extension of the child. As an extension, the child must take its point of view in order to instruct it. Points of reference, direction, all of the space concepts necessary to mapping are involved in working with the turtle.

Children can also use a screen turtle. The screen turtle is a small triangular pointer on the microcomputer's screen which responds to simple commands: For example FORWARD moves the turtle in the direction it is facing a given number of units (Abelson, 1982). The screen turtle also can draw. The

user can imagine that the screen turtle carries a pen, which will leave a trace of its path on the screen as it moves while the pen is down. If its imaginary pen is up it will not leave a trace of its path. The commands `PENUP` and `PENDOWN` make the turtle raise and lower the pen. This ability to control whether or not a line is being traced on the screen along with the screen turtle's ability to move in many directions, and as far as the user wishes, gives children the ability to create all sorts of drawings and to erase or change them with little effort.

Programming the turtle is an activity of describing things. If the child wishes to draw a square the turtle can be instructed to move forward for a particular distance. When it's moved this distance it will have to turn, change directions, and move forward an equal distance, then it will have to make another turn and move the same distance, finally a last turn will be made and the fourth side of the square drawn. In order to determine how the turtle should turn, children at first need to stand up and walk out the square paying attention to the direction they are moving in. This physical acting out of the turtle's movement eliminates frustration and enables children to work out the directions for complicated drawings. The descriptions are phrased so that they can be interpreted by a microcomputer but that is not really so important. These computational descriptors provide a perspective which incorporates those aspects of the construction of the space around us which are the foundation of mapping.

Once children become familiar with microcomputers they can begin to build microworlds. These are worlds represented on the microcomputer which are limited to a very few variables designed by the child. For example, Lawler (1982) describes a beach microworld. This is a microworld which has objects with

different colors and shapes moving against a static but vivid backdrop. The beach microworld contains many possible variations of activity.

SUN can be the name of the procedure that creates a yellow ball on the screen. The word UP can name the command that moves the SUN up. Repeated often enough, UP puts the SUN in the sky above the BEACH. Another word, such as SLOW or FAST, can set the SUN in motion. Because new procedures are easily defined, the child could even make the SUN ZOOM. Such flexibility permits the microworld to be tailor-made to suit any child. To the extent that the child participates in defining the objects to be part of the world, their characteristics and the actions they are to perform, the microworld is also constructed by the child her/himself.

Lawler (1982) describes a BEACH microworld which incorporated the following sets of objects and actions among others.

Objects: BEACH, BIRD, BOAT, BOY, CAR, DOG, FISH, GIRL, HOUSE, JET, KID,
MAN, MOON, OAK, PINE, PLANE, PONY, STAR, SUN, TRUCK, VAN, WAGON
Actions: UP, DOWN, MOVE, BACKWARD, FAST, FLY, HALT, SAIL, SHOW, SWIM,
TURN, WALK, ZAP, ZOOM, PAINT BLACK, PAINT GREEN

Combining these objects and actions can allow the child to explore most of the two-dimensional movable space concepts fundamental to mapping. The child is exploring these concepts in a two-dimensional manner and so does require the actual physical experiences with these concepts prior to working with a microworld. When the child has such a background of experience, the microworld is fun, challenging, and understandable. The microworld is less abstract than are drawings because its objects can move. The child can rearrange the microworld as she/he wishes. While they have many realistic characteristics, such as motion, microworld objects cannot be picked up and handled. The microworld

is not the usual two-dimensional representation but neither is it three dimensional. Because it is neither it makes the transition from physical experience to two dimensional abstract activity, such as reading, easier. It also has an asset which often doesn't occur in either the real world or in two-dimensional representations of it. The child is in control, will make mistakes, must decide how to remedy them, can observe and control motion, and can observe the effects of variables and of altering those variables. The microworld is active mapping of a world in motion. It offers infinite potential for the investigation of those concepts which construct mapping.

LOGO has many possibilities for use by children, from drawing a square to moving in a microworld. The major feature of all this is children's experience with programming. They are actively instructing the microcomputer. In doing so, they must grapple with and comprehend many mapping concepts. This active effort gives the child experience in working through mapping concepts and is the major value of using LOGO.

For those who don't have access to LOGO, it is possible to do some drawing with BASIC and to do some mapping with the microcomputer as a result. While BASIC offers less potential than does LOGO it does have some. Since microcomputers recognize BASIC this moderate drawing ability is available to all microcomputer users whereas LOGO requires its special purchase as an additional language for the microcomputer.

Using the directions given in most microcomputer manuals and the BASIC term "PLOT," it is possible to draw a variety of figures and to store these for use as needed. The directions will be more complicated in BASIC than they would be in LOGO so children cannot program the computer. The adult can create programs,

however, which children can use. A simple program of this type would be the one which asks which of two colored rectangles is larger. This type of program is useful because it is interactive. It is interactive because it asks the child to make a choice, give the child feedback about the choice made, and then presents a follow-up activity which can vary from child to child depending on how the child responded to the initial problem. While it is not as active as LOGO programming it is much more interactive than a paper and pencil activity. This is because the microcomputer does respond to the child.

Adults who wish to develop such mapping related activities using BASIC will find microcomputer manuals of assistance, or to save time, should examine some of the many books of programs now available. These books give a complete list of instructions for a program, some of which are drawing programs. The user needs only to type out these instructions exactly. The only problems with such books is that more programs in education have been written for some makes of microcomputers than for others. Programs are also available in computer magazines and newsletters.

All microcomputers have the potential of offering the child yet another form of experience with mapping concepts. Children benefit most from active, physical experience with mapping. Computer mapping should be strongly considered as an adjunct to physical experience. Because of their interactive possibilities computer activities have great potential for involving the child in mapping activity that is abstract but also can have a strong element of the concrete and interactive if LOGO is used or of the interactive if BASIC is used.

Conclusion

Teachers should initiate mapping experiences with young children by providing motor experiences inside and outside the classroom. These can be followed by a transition in mapping experiences which moves from work with photographs and three dimensional miniatures and models, to two dimensional paper, and finally with lines. Since not all children will be able to progress to lines, opportunities should be offered at all levels in each area of study. Microcomputers can add a new aspect of experience for children in a variety of ways ranging from simple games with the area of squares to the construction of complex microworlds.

Maps and globes must be present in the classroom and need to be referred to frequently. While young children cannot be expected to interpret commercial maps easily, they can work with student and teacher-made three and two dimensional maps. Such maps can, for the most part, center on themes familiar to the children and should originate in actual exploratory work done outside the classroom by the children. Varying textures and contours will enhance their usefulness with young children.

Adults who work with young children should "plunge" into mapping from the very beginning. Motor activity and topological studies form a base from which the teacher and children can build a mapping program of progressive sophistication. This mapping program should develop and enlarge relationships derived by the children from a variety of concrete exploratory experiences. Young children can, and should be encouraged to, discover the purpose and use of maps.

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